are introduced and calculations are made in full, just as in ordinary practice. Miller's system of indices is used throughout, and the rules for making spherical projections are developed at some length. This is the only elementary text-book in which the subject of spherical projection is given the attention it naturally merits as being the method which is now almost universally used by the most eminent crystallographers.

Among the publications of the last few months which contain more or less of interest in mineralogy and petrography may be mentioned—

Professor A. Kenngott, M.D.—Handwörterbuch der Mineralogie, Geologie und Palaeontologie, III. Breslau, 1887. Eduard Trewendt.

Dr. C. Rieman.—Taschenbuch für Mineralogen. Berlin, 1887. Julius Springer.

F. Toula.—Mineralogische und petrographische Tabellen. Leipzig. Freytag.

J. D. Dana.—Manual of Mineralogy and Petrography.[1] 4th ed., 1887. New York: John Wiley & Sons.

Professor W. O. Crosby.—Tables for the Determination of Common Minerals, chiefly by the Physical Properties, with confirmatory Chemical Tests.[2] Boston, 1887. A. Crosby.

Professor A. H. Chester.—Catalogue of Minerals Alphabetically Arranged, with their Chemical Composition and Synonyms.[2] New York, 1886. John Wiley & Sons.

T. Sterry Hunt.—Mineral Physiology and Physiography.[2] Boston, 1886. S. E. Cassino.

Professor W. O. Crosby.—Geological Collections. Mineralogy. Boston Soc. Nat. History, 1886.

A. C. Lawson.—Report on the Geology of the Lake of the Woods Region. Part CC. Annual Report of the Geological and Natural History Survey of Canada. Montreal, 1885.

C. D. Lawton.—Mineral Resources of Michigan for 1885. By authority. Lansing, 1886. Thorp & Godfrey.

Mineral Resources of the United States for 1885. Washington, 1886. Government Printing Office.

Dr. P. Groth.—Grundriss der Edelsteinkunde. Leipzig, 1887. Engelmann.

BOTANY.[3]

A Couple of Botanical Estrays.—A botanical discovery of some interest has recently been made in the neighborhood of Iowa City. Two species of Lycopodium have been found. So far as the writer can learn, this is the first record of such plants within the limits of Iowa. Lycopodium has been sought in all

[1] Reviewed in Science, 1887, p. 304.
[2] Reviewed in Science, February, 1887, p. 142.
[3] Edited by Prof. CHARLES E. BESSEY, Lincoln, Nebraska.

directions, but hitherto is not reported anywhere west of the Mississippi River, south of Pine County, Minn. The discovery is the more interesting when we know that the two species found, grow side by side within the limits of a very narrow area. A space ten by fifteen feet includes the entire station. All the hill-sides in the vicinity were searched in vain for other specimens. The plants did not fruit last year, are feeble, depauperate specimens of their species, and probably destined now to speedy extinction. The few white oaks, remnants of the "forest primeval," which have long afforded shelter, are now cut away, the hill-side becomes a pasture-field, and Lycopodium will be found no more.

To account for this isolated station, this peculiar distribution, is not easy. One is reminded of Scolopendrium, Shortia, and the like. Probably other stations will be found to the north which may serve to put these little specimens in geographical connection with their kin. This can hardly be the last tarrying-place of a plant which must at one time have covered all the northern portions of the State.—*T. H. McBride, Iowa City,* May 7, 1887.

The Origin of the Tomato from a Morphological Standpoint.[1]—There are two methods by which the cultivator can determine the origin of vegetables which have been long in cultivation. He can follow the history of the plant to its introduction into gardens and may then be able to identify it with a wild species, or he may reason from inference from the morphology and direction of variation of the plant in hand. The latter method may be illustrated by the tomato.

I will suppose, for my purpose, that no record exists as to the introduction of the tomato, or in regard to its characters, at any time before the present.

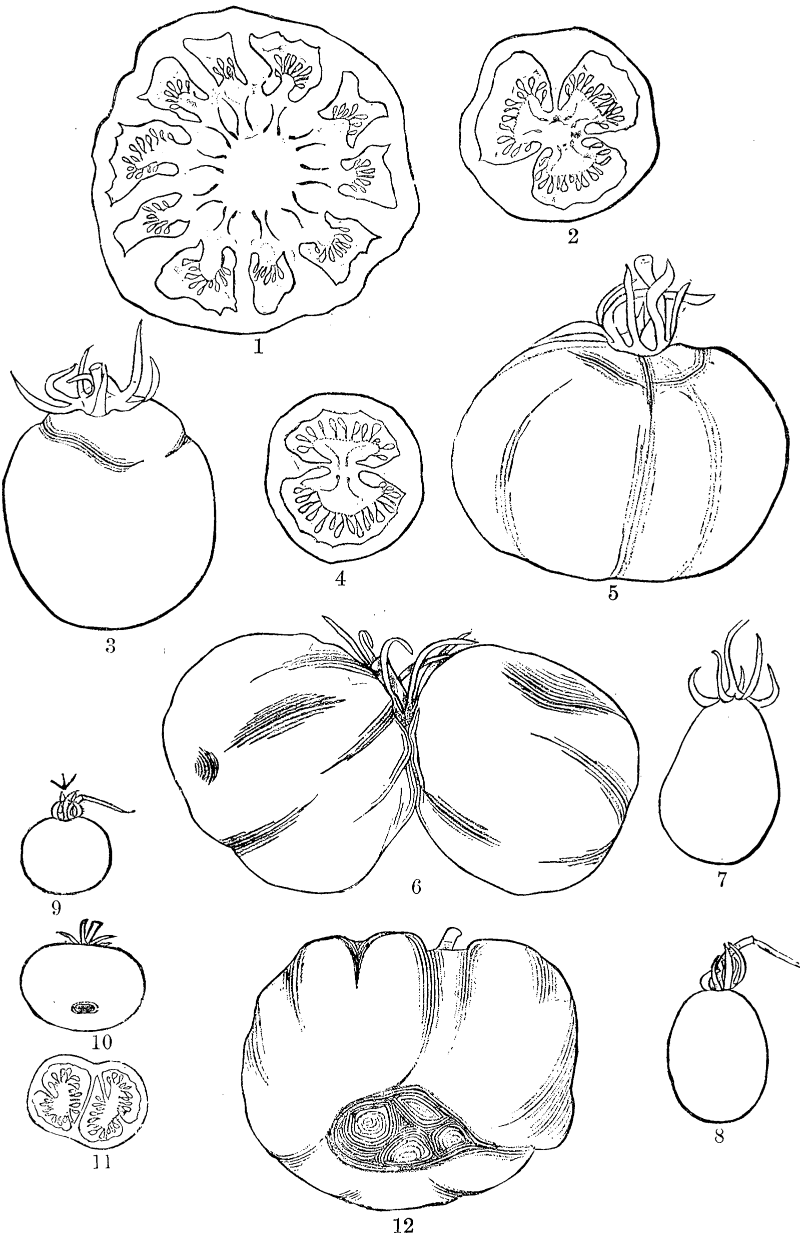
The fruit of the large tomato is seen at once to be extremely variable. This variability lies mostly in size, form, and number of cells. The number of cells, as seen in a cross-section of the fruit, may be taken as a measure of size and form. Fig. 1 represents a cross-section in which ten partial cell-divisions project from the walls of the fruit. This is a section of a Trophy. If we were to examine a hundred specimens of this variety we should find no two alike in shape and number of cells, and, consequently, in shape and size of fruit. Moreover, we should find the variations to be very great. Now, fruits in wild nature possess a definite number of cells, and of definite shape. The Trophy, then, is a monster; it is unnatural. To find a fruit nearer the original wild type we must find one more constant in its character. We examine critically every large-fruited sort,

[1] This paper is a revision and extension of one which first appeared in the *American Garden.*

and we find each one monstrous in regard to form and number of cells, but some are less so than others. The least monstrous are always those with the fewest cells. The fewest-celled fruits in our culture, then, must be nearest the original type. Fig. 2 represents a sectional view of a normal Criterion. The cells are three, incomplete. The fruit, Fig. 3, is oblong, mostly regular. The smallest, most regular specimens of this variety are incompletely two-celled, Fig. 4. On the other hand, abnormal specimens of this variety are many-celled, as shown by the partially-lobed fruit in Fig. 5. Occasionally the tendency to monstrosity extends to the flowers, and a twin is the result, Fig. 6. The Criterion presents nearly the whole record of development within itself. Its regular, small, normal, two-celled fruits approach the original type. Figs. 5 and 6 attest an excessive influence of cultivation. All the fruits here represented grew upon the same plant. The Criterion must be compared with the pear-shaped and egg-shaped sorts. Fig. 7 represents one of the Pear tomatoes. It is almost uniformly two-celled, or, in its larger form, the King Humbert, it becomes three-celled, and connects completely the Pear tomato and the Criterion. Below the Pear in point of development is the Plum tomato, Fig. 8. It approaches more nearly a spherical form, and is almost uniformly two-celled. Still lower is the Cherry tomato, Fig. 9,—the smallest and simplest of them all, and two-celled. This is our nearest approach to the wild type. The first tomato known to man could have been little else than this Cherry tomato. Here the cell-division is perfect, and gives every evidence of being normal. The first tomato must have been a two-celled fruit, and its shape spherical, or nearly so. The Pear tomatoes are also completely two-celled,—that is, the cell-division extends entirely across the fruit,—and this gives us reason to suppose that they may have existed in wild nature also. Granting this, they nevertheless give evidence of development from the Cherry tomato, as we have seen from the intermediate Plum varieties, Fig. 8. In cultivation they present fewer constant specific marks than the Cherry sorts.

Occasionally, however, the Cherry tomato broadens, as in Fig. 10, and becomes more or less completely three- or four-celled, Fig. 11. This figure shows the complete cell-division which separates the normal tomato into halves. This variation is the beginning of the flat and angular tomatoes. Small developments from it are Green Gage, Improved Large Yellow, and White Apple. As the fruits increase in size by the interposition of new cells, they take on abnormal shapes. Adventitious cells are often pushed into the centre of the fruit, giving rise to the familiar structure represented on the top of Fig. 12. Often the rupture caused by these adventitious cells takes the form of an irregular line rather than a ring, as in the illustration. Most of the large varieties of tomatoes give unmistakable evidence of development

PLATE XVIII.



from the Cherry tomato. So obvious is the direction and manner of variation in the tomato that among seventy-five varieties grown in our gardens last year there were none which refused to be classified, in relation to their origins and tendencies, as to whether the earliest variations had been directly from the Cherry tomato or through the Pear tomato. So clear does this manner of variation become, after a few weeks of study, that I am compelled to place more confidence in this method of ascertaining the origin of our cultivated tomatoes than in the records of old herbals.

We cannot so positively determine the color of the original tomato. Five-sixths or more of all our tomatoes are in various shades of red. From this fact we infer that red is the strongest and prevailing, hence the original, color.

The classification of cultivated tomatoes, upon morphological principles, may be represented as follows:

LYCOPERSICUM ESCULENTUM Miller, "Gard. Dict." (1768).

§ A. *Cerasiforme.*—Cherry tomatoes (*L. cerasiforme* Dunal, "Hist. Solan.," 113). Fruit spherical, two-celled,—the original type.

§ B. *Pyriforme.*—Pear and Plum tomatoes (*L. pyriforme* Dunal, l. c., 112). Fruit oblong or pyriform, two-celled, conspicuously pendent.

§§ A. *Vulgare.*—Plant weak, requiring support; leaves ordinary.

Group 1. Angular tomatoes. Fruit medium or below in size, mostly very flat, plane on top, more or less cornered, the lobes most conspicuous on the bottom and sides. Developments directly from the Cherry tomato, through the type of Improved Large Yellow, etc. Tom Thumb may be taken as the type of the group.

Group 2. Apple-shaped tomatoes. Fruit normally more or less rounded on top, most of the irregularities being due to the interposition of adventitious cells in the centre of the fruit. Direct developments from the Cherry tomato, through its longer and more regular forms. The "ringed" or "lined" character of the apex of the fruit is oftenest seen in this group. The Paragon may be taken as a type of the group.

Group 3. Oblong tomatoes. Fruit usually as long or longer than broad, the sides very firm. Developments from the pear-shaped variation. Criterion, in its normal forms, may be considered the type.

§§ B. *Grandifolium.*—Habit the same as in sub-section A; leaves very large; leaflets fewer (about two pairs), large (the blade three to four inches long and an inch and a half wide), entire, the lower side strongly decurrent on the petiolule. Leaves of very young plants are entire! Singular plants of recent development, represented by but few varieties, of which Mikado may be taken as type.

§§ C. *Validum.*—Stem very thick and stout, the plants nearly sustaining themselves; two to three feet high; leaves very dark green, short, and dense, the leaflets wrinkled and more or less recurved. Odd plants, with the aspect of potatoes, represented by French Upright and the New Station.

Another species, *Lycopersicum pimpinellifolium* Dunal, "Solan. Syn.," 3, the Current tomato, is cultivated as a curiosity.—*L. H. Bailey, Jr., Agricultural College, Mich.*

Experiments with Lima Beans in Germination.[1]—After reading some of the suggestive writings of Darwin, I began a few experiments with some Lima beans. About forty seeds were planted in the damp sand placed in a cellar. Of these twenty were placed on edge with the scar or hilum downwards, and twenty in a reverse position with the hilum uppermost.

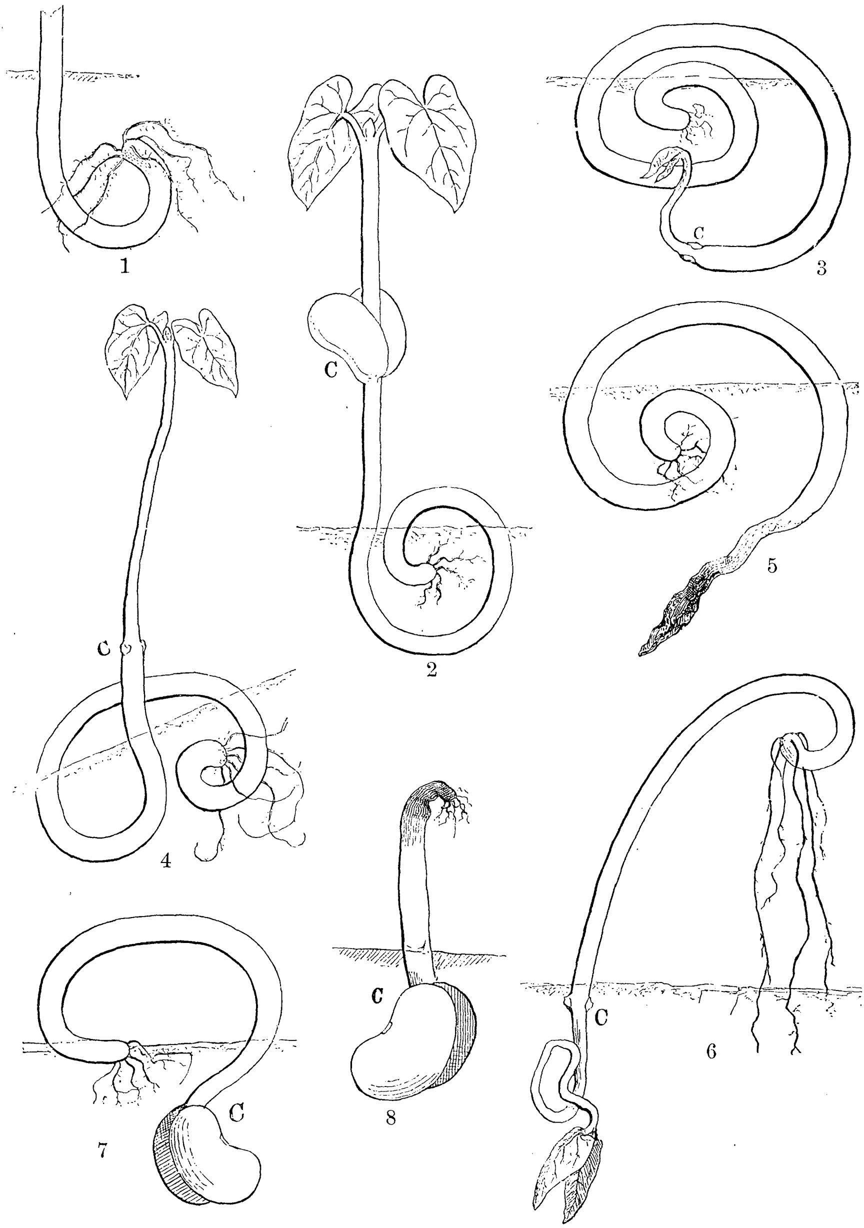
In most cases seeds of this species, when germinating, produce a long radicle, which carries the cotyledons some inches above ground. In this case two seeds produced a very short radicle,—perhaps half an inch long,—so that the cotyledons remained beneath the surface, as is usually the case with germinating peas. The beans planted with the eye down behaved well and came up promptly, all of them, while those placed in the reverse position went through with a great variety of manœuvres, and even then some of these perished in the attempt to make young plants. After some delay a considerable portion of them came out of the ground. Most of these bent the radicle into a half-circle, or, rather, that of an ox-bow, with one arm much longer than the other, carrying up the cotyledons. In making growth in the cellar nearly all of the young plants sent from one to several roots above the surface, where they usually re-entered the sand.

Four out of the twenty with the scar-edge up, after exhausting the nourishment stored in the cotyledons, perished in their attempts to make a successful growth. The lengthening radicle arched up out of the sand, but the plumule finally decayed.

In the sandy soil of my garden were placed twenty-five seeds in the manner last mentioned. A few came up very promptly, but for some time most of them seemed to rest beneath the sur-

[1] Read at the Montreal meeting of A. A. A. S. in 1882, and only a very brief abstract printed, without illustrations.

PLATE XIX.



face; but a week of rainy weather brought most of the rest to the surface in some form or other. Nine out of twenty-five sent the lower end of the radicle, with its roots, from three-fourths to two and oné-half inches above the surface. The plumule for a time remained green, and the cotyledons were not yet exhausted; but in time all of these perished without bringing any green leaves to the surface.—*W. J. Beal, Agricultural College, Mich.*

EXPLANATION OF THE PLATE.

No. 1. The first of those to come up, where the hilum was placed uppermost, usually took the form of this figure.

No. 2. This represents one of those in which the hilum was placed uppermost.

No. 3. In this case the seedling is still struggling to send its plumule to the surface. The cotyledons, which were attached at C, have been rubbed off by the movements of the young plant through the sand.

No. 4. One plant is here represented in which the partially-exhausted cotyledons had been rubbed off.

No. 5. This represents one specimen in which the cotyledons have disappeared and the plumule has decayed.

No. 6. In this case the cotyledons have disappeared; the plumule and primary leaves were still green; some of the roots were still fresh in the soil, though the lower end of the radicle was elevated nearly three inches above the surface of the sand.

No. 7. Six out of twenty-five planted in open ground with the hilum uppermost were much like this figure, and likely to succeed in becoming good plants.

No. 8. Nine out of twenty-five planted as above in the open ground thrust the radicle with its roots nearly straight up out of the soil, sometimes as much as two and one-half inches, when the seedlings perished.

[All the figures were made by Will. Holdsworth.]

ENTOMOLOGY.[1]

Note on Respiration of Aquatic Bugs.—Among the most common insects found in our smaller ponds are those popularly known as "Water-Boatmen." Of these, the more abundant species pertain to two genera,—*Corisa* and *Notonecta.* In each of these genera the insect carries about with it, in its course through the water, a bubble of air, which it uses for respiration. At one time I kept for a considerable period several aquaria containing these insects upon the table where I was working. Some interesting phenomena connected with their respiration attracted my attention. Other duties interfered with the completion of my observations, and I now publish this note merely to call the attention of other observers to the subject.

The habits of the two genera are very different. In each the insect comes to the surface of the water at intervals to obtain a supply of fresh air; but in the case of *Corisa*, inhabiting well-aerated water, this does not seem to be absolutely necessary. The favorite attitude of the species of this genus when at rest is clinging to some object near the bottom of the aquarium; here they will remain for long periods, evincing no desire to rise to

[1] This department is edited by Prof. J. H. COMSTOCK, Cornell University, Ithaca, N. Y., to whom communications, books for notice, etc., should be sent.